



G2

a new erosion model

towards a pan-European service
for regional erosion monitoring

geoland:2

Contributors

Join Research Centre – Institute for Environment and Sustainability - Land management & Natural Hazards Unit

- Luca Montanarella
 - luca.montanarella@jrc.ec.europa.eu
- Panos Panagos
 - panos.panagos@jrc.ec.europa.eu



Aristotle University of Thessaloniki – School of Forestry and Natural Environment – Lab of Forest Management and Remote Sensing

- Ioannis Gitas
 - igitas@for.auth.gr
- Christos Karydas
 - xkarydas@agro.auth.gr



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Model features

Erosion type	Sheet – interrill
Erosion features	Soil loss (actual)
Erosion processes	Splash, runoff
Spatial scale	Landscape
Temporal scale	Month (long term, averaged)
Mathematical basis	Empirical (inherited from USLE)
Type of assessment	Quantitative (t/ha)

A = R K L S C P

Wischmeier and Smith 1978

G2 formula

$$E = (R * V) * (S * T * I)$$

E	Actual soil loss (t/ha)	
R	Rainfall erosivity (modified from USLE by G2)	DYNAMIC FACTORS
V	Vegetation retention (developed by G2)	
S	Soil erodibility (modified from USLE by JRC, 2000-5)	STATIC FACTORS
T	Topographic influence (USLE modifications, 1996)	
I	Interception of slope length (developed by G2)	

$$E = 210 + 89 \log_{10} I,$$

Wischmeier and Smith 1978

R factor

$$R = 210 + 89 \log[s * P / (d * h)]$$

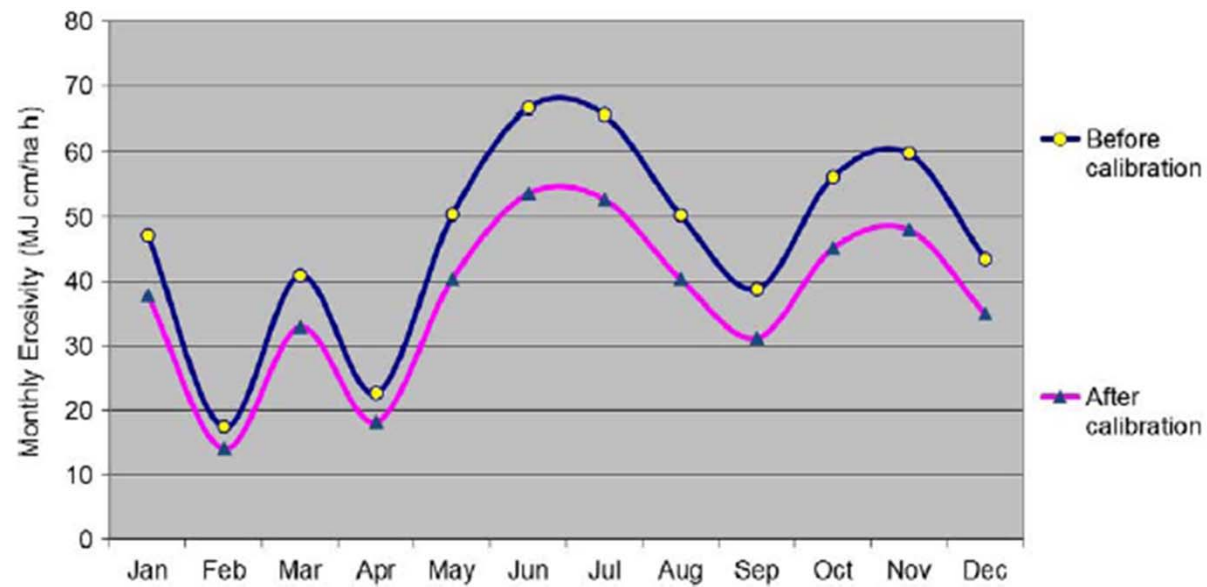
- R: rainfall erosivity of a specific month (MJ cm/ha h)
- s: an empirical monthly storm factor (corresponding to I_{max30} of USLE)
- P: rainfall volume of the month (cm)
- d: mean rainy days per month
- h: mean rainy hours per day of the month



Storm factor 's'

- Expresses how more intensive are storms during a specific month in relation to the less intensive month of the year
- Method for estimation
 - Calculation of EI values per month from available rain recording periods (e.g. 30-min, 1-h, etc) using the original USLE formula
 - Averaging of calculated EI values per month
 - Normalization of the averaged EI value according to the minimum value in the set
 - Calibration according to measured data
- The technique is based on the principle of cumulative EI figures developed in the framework of USLE

Storm factor calibration - example

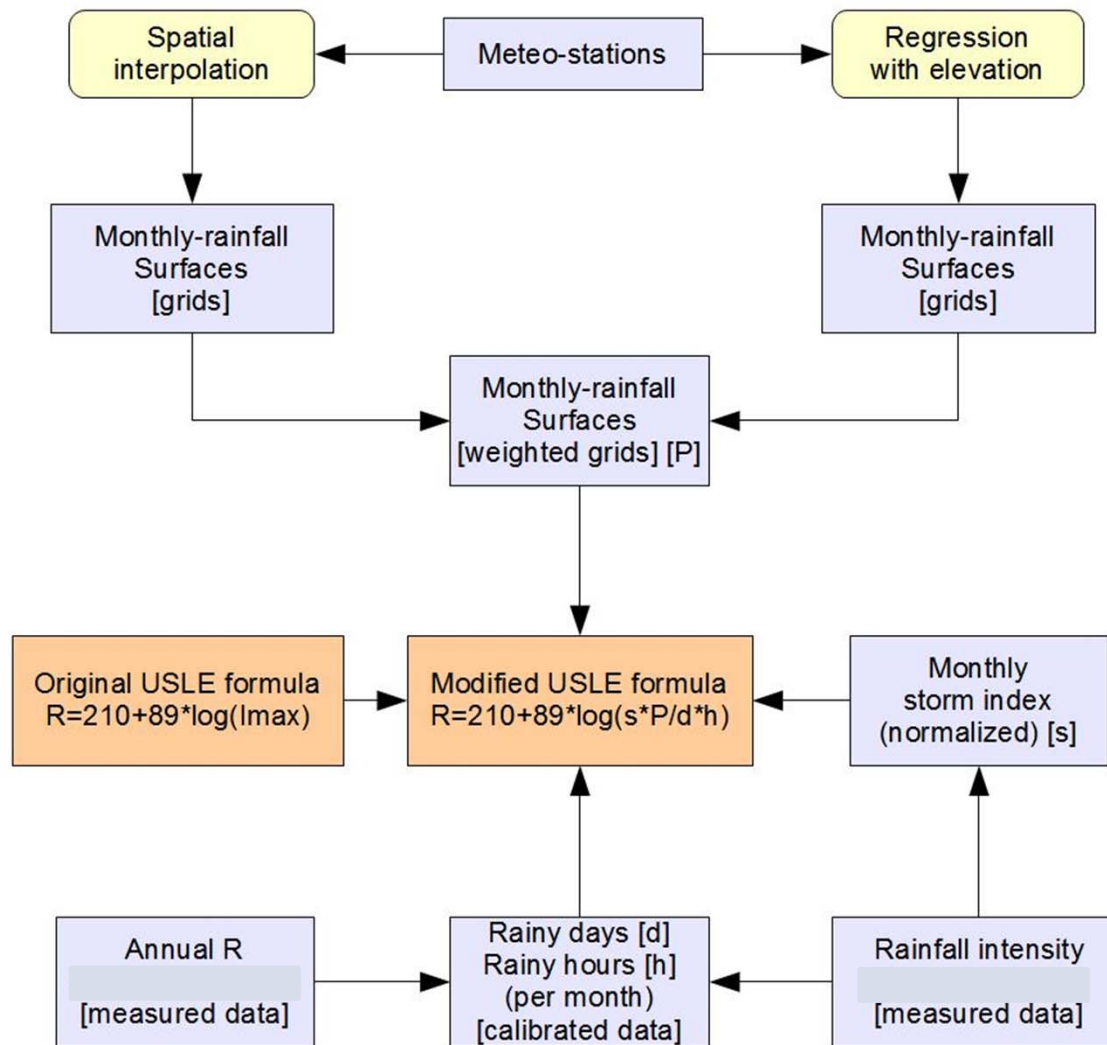




Spatial distribution of 'P'

- Rainfall of each month is tested across elevation and the coefficient of determination (r^2) is recorded
- Monthly rainfall maps are created using the most reliable function of P with elevation
- Monthly rainfall prediction maps are created using Kriging interpolation
- The two rainfall surfaces (from regression and interpolation) are weighty averaged according to the results of the regression
- In cases where the coefficient of $r^2 < 0.10$, the rainfall surface is identical to the Kriging results

R overview



$$V = \frac{F_{Soil} + \frac{F_{Soil}}{LAI+1}}{2}$$

Panagos et al. 2011

V factor

$$V = \{F_{soil} + [F_{soil}/(LAI+1)]\}/2$$

- V: vegetation retention (a normalised monthly vegetation parameter)
- F_{Soil}: fraction of soil that is visible in the vertical direction, sunlit or shaded from the canopy
 - expresses percentage of soil in the surface unit (cell)
 - range: [0,1]
- LAI: total one-sided area of leaf tissue per unit ground surface area
 - unit: m²/m²
 - range: [0,6]



Preparation of FSoil and LAI grids

- Quality assessment of the available grids; exclusion of scenes/areas with
 - clouds
 - shadows
- Temporal integration of the selected grids
 - Targeted date: the 15th of each month
 - Input from different years (minimum: 3)
 - Linear temporal interpolation of grids



S factor

- Input parameters
 - First approximation by
 - Soil texture class
 - Corrections by
 - Crusting property
 - Double-application of low pass filter 3x3
 - Organic matter content

First approximation

Code	Description	% clay	% silt	% sand	S
0	No information	–	–	–	
9	No texture (histosols, ...)	–	–	–	
1	Coarse (clay < 18% and sand > 65%)	9	8	83	0.0115
2	Medium (18% < clay < 35% and sand > 15%, or clay < 18% and 15% < sand < 65%)	27	15	58	0.0311
3	Medium fine (clay < 35% and sand < 15%)	18	74	8	0.0438
4	Fine (35% < clay < 60%)	48	48	4	0.0339
5	Very fine (clay > 60%)	80	20	0	0.0170

$$S_c = S_o * e^{(-0.1013 * OM)}$$

Panagos et al. 2011

Organic matter

- $S_c = S_o * e^{(-0.1013 * OM)}$
 - S_c : corrected S
 - S_o : original S (before correction for organic matter)
 - OM: content of organic matter per cent (%)

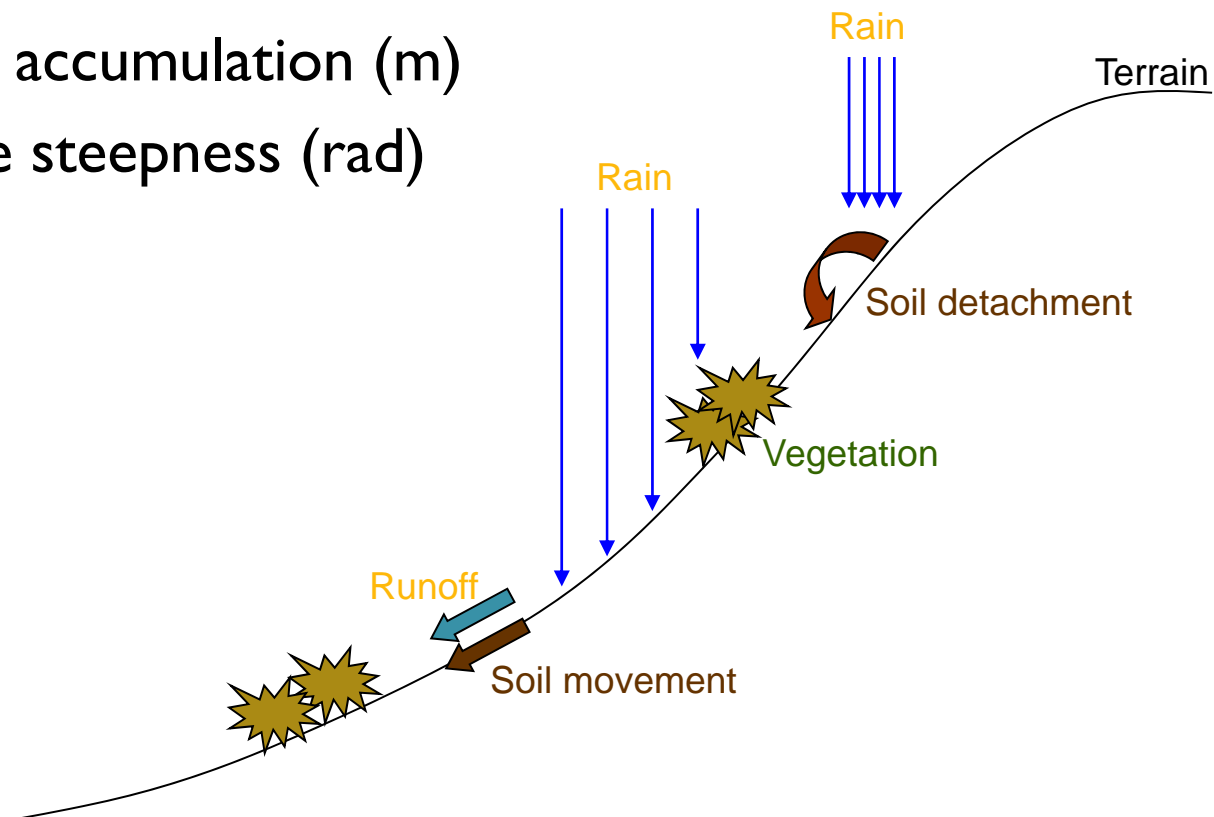
$$LS = (A_s/22.13)^{0.4} * (\sin \beta / 0.0896)^{1.3}$$

Moore and Burch (1986)

T factor

$$T = (A_s/22.13)^{0.4} * (\sin \beta / 0.0896)^{1.3}$$

- A_s : flow accumulation (m)
- β : slope steepness (rad)





T-calculation steps

- Calculation of flow accumulation grid (A_s)
- Values 0 in the flow accumulation grid are reset to 1
- Slope steepness β is calculated in degrees
- Slope steepness β in degrees is converted to radians
- A_s is multiplied by the cell size in m
- $T > 10$ is set equal to 10

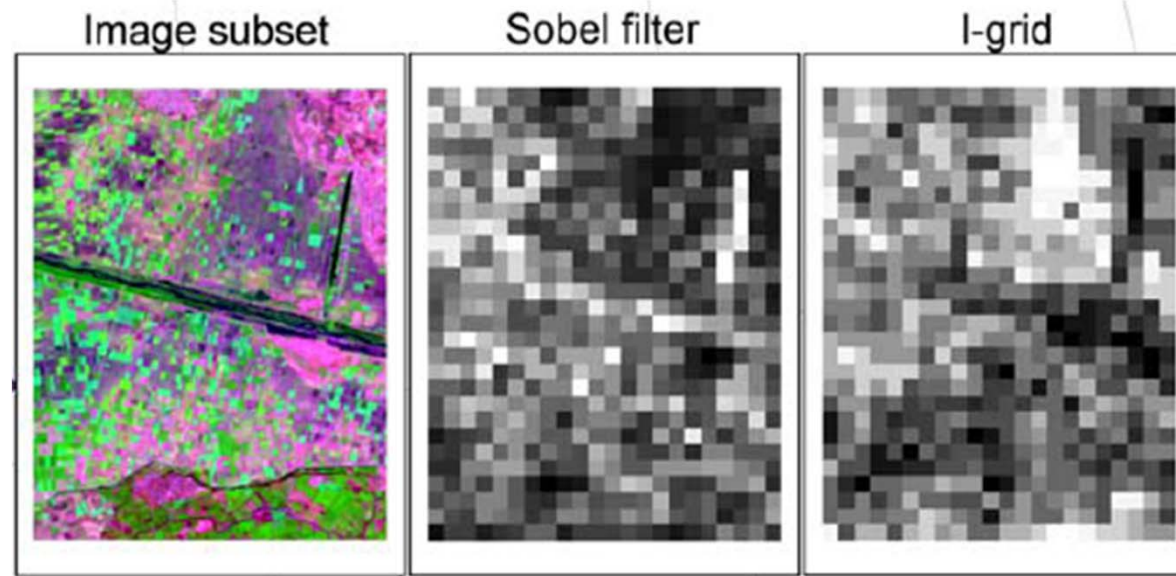
$$I = 1 - \sqrt{(S_f/255)}$$

Panagos et al. 2011

I factor

- All anti-erosion measures target to intercept rainfall runoff by reducing the slope length
- Steps:
 - Sobel filter 3x3 on NIR-band of SPOT (25m)
 - Resampling to 300m
 - Conversion of Sobel values into I values
 - Formula: $I = 1 - \sqrt{(S_f/255)}$

I-factor estimation - example



Data sources

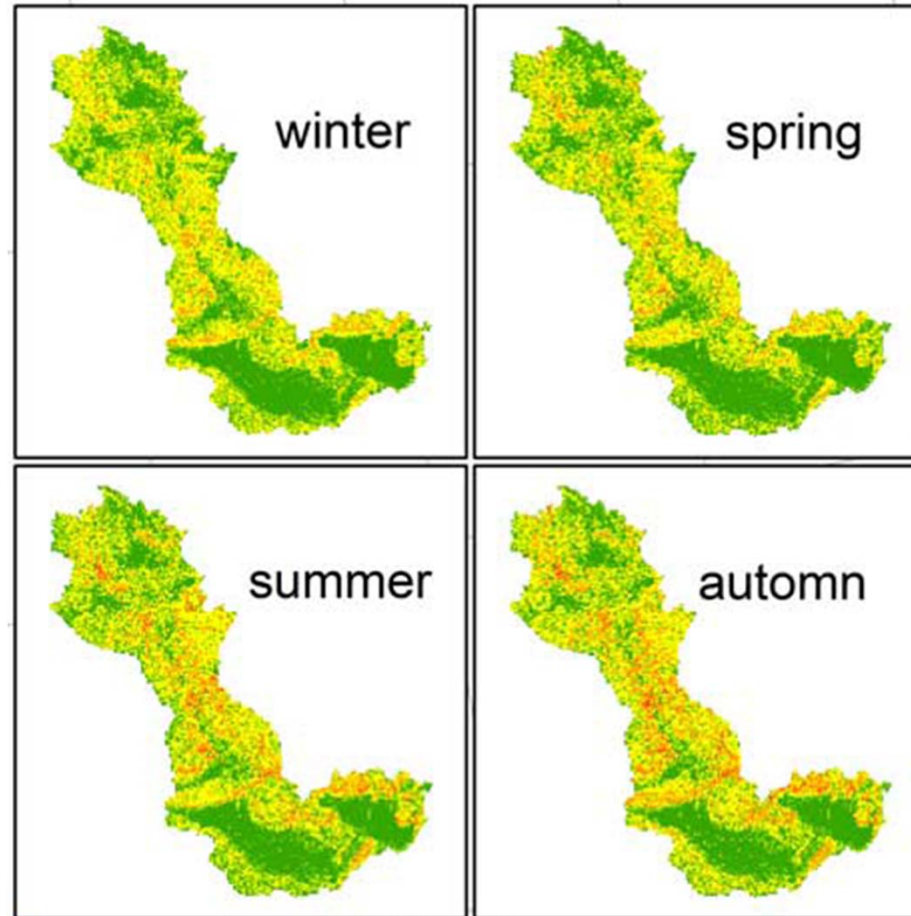
Model parameter	Input data	Scale/Detail
R, Rainfall erosivity	Weather stations	25 Stations Month-step
V, Vegetation retention	BioPar (originated from MERIS satellite)	300 m pixel size
S, Soil erodibility	European Soil Database Soil Organic Carbon	1:1.000.000 1 Km cell-size
T, Topographic influence	ASTER DEM	30 m cell-size
I, Interception of slope length	SPOT mosaic (Image 2006)	25 m pixel size



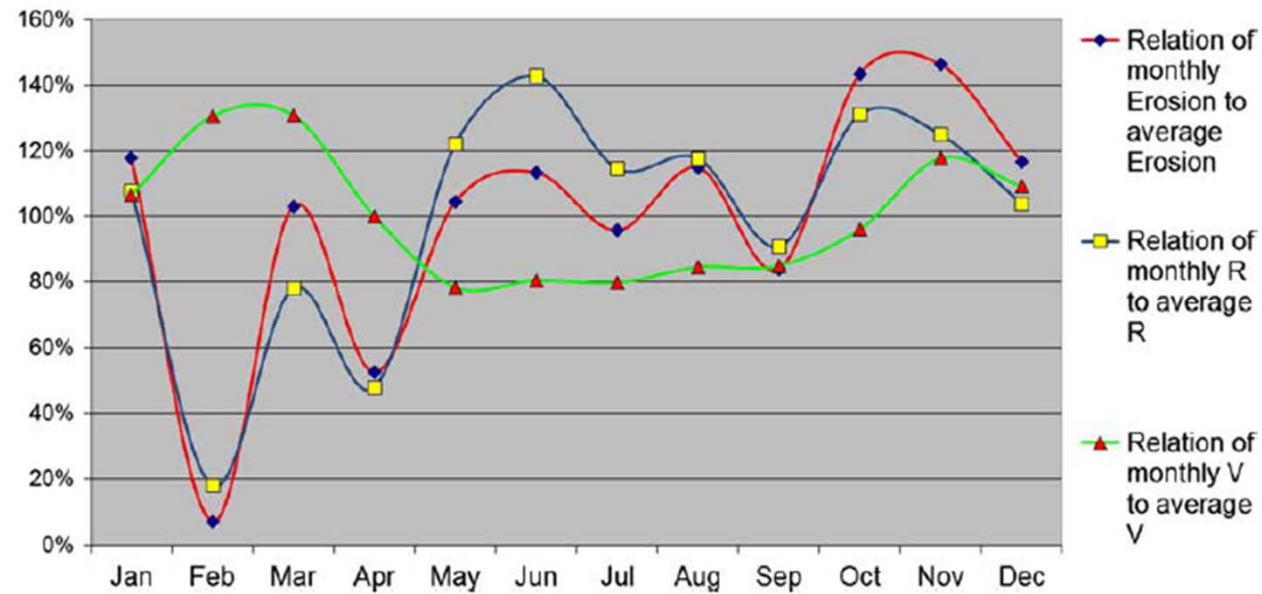
Outputs

- Month-step erosion maps
 - Seasonal erosion maps
 - Annual erosion maps
- Month-step erosion profiles per land use

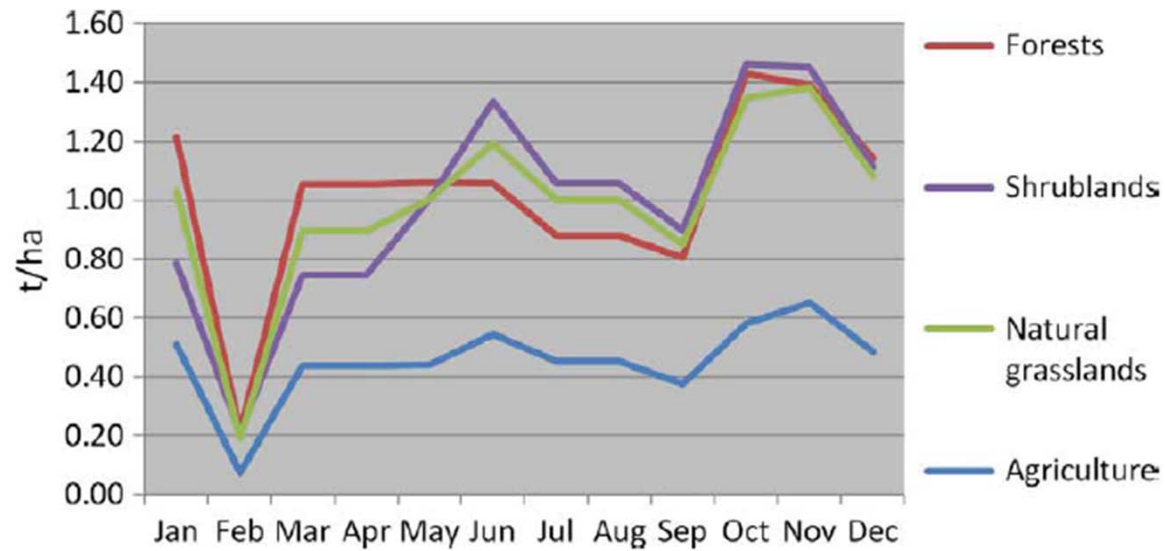
Seasonal maps - examples



Input and output parameter trends



Erosion trends per land use





G2-model profile

- A generic model appropriate for implementation throughout Europe
- Use of harmonized standard input datasets
- Need for calibration
- A dynamic model (takes into account seasonal changes of rainfall erosivity and vegetation retention)
- A simple model – low data demand
- A realistic model (preliminary validation with experimental erosion measurements in the cross-border river basin of Strymonas/Struma in Greece and Bulgaria)
- A feasible, data-driven model



Contact and links

- Panos Panagos

- E-mail: panos.panagos@jrc.ec.europa.eu
- Tel:

- Links

- International Journal of Digital Earth
 - <http://dx.doi.org/10.1080/17538947.2011.587897>
- www:: <http://eusoils.jrc.it>
- <http://www.gmes-geoland.info/>